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Do tobacco taxes influence starting and quitting smoking? A discrete choice approach using evidence from a sample of Irish women

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**Do Tobacco Taxes Influence Starting and Quitting Smoking?
A Discrete Choice Approach Using Evidence from
a Sample of Irish Women**

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Do Tobacco Taxes Influence Starting and Quitting Smoking? A Discrete Choice Approach Using Evidence from a Sample of Irish Women

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Preliminary draft – comments are welcome but please do not quote without permission

Abstract: This paper uses a discrete choice approach to investigate factors influencing starting and quitting smoking, in particular the role of tobacco taxes. Standard probit analysis is applied to both starting and quitting. Tobacco taxes appear to exert a negative influence over decisions to start smoking, but their effect on quitting smoking is less clearcut.

JEL Codes: I18, D12, C41.

Keywords: Probit, Ordered Probit, Smoking.

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Do Tobacco Taxes Influence Starting and Quitting Smoking? A Discrete Choice Approach Using Evidence from a Sample of Irish Women

1. Introduction

There is ample medical evidence indicating the adverse effects of tobacco consumption upon health (see Madden, 2001a, for a recent summary). Recent Government publications in Ireland have suggested the long-term goal of a “tobacco-free society”. As the accompanying letter to a recent Government report stated: “...there is a common objective of seeking the most effective measures possible to dramatically reduce the level of smoking in our society and above all to prevent our children from starting to smoke” (Mooney, 2000). It follows that identifying the factors behind the decision to smoke and the decision to quit is crucial in terms of formulating policy.

A recent paper examined the factors influencing participation in smoking, the amount smoked and factors influencing quitting in a discrete choice framework using a sample of Irish women (Madden, 2001a). However, one factor absent from that work was the influence of a crucially important tool of government policy in its drive towards a tobacco-free society, the rate of taxation on tobacco and tobacco products. The data in Madden (2001a) was a single cross-section of Irish women and the absence of any variation in tax or price meant that it was impossible to infer the effect of these variables on smoking behaviour. The dataset however did include some retrospective data on the year of quitting smoking (for those women who quit) and also the number of years smoking (from which could be inferred the year of starting smoking). Using this data, and incorporating the relevant tax rate for the year in question, it is possible to construct a pseudo-longitudinal data set with the tax rate as a time-varying covariate. Following this it is then possible to model the decision to start/quit smoking as either a discrete choice or to model the duration before starting/quitting. We adopt the discrete choice approach in this paper using a standard probit specification.¹

Note that we are not trying to estimate what the optimal tax on tobacco should be. For a comprehensive recent survey dealing with the US, see Evans et al (1999). The key issues in this literature appears to be (a) which external costs should be included

¹ For an example of a duration analysis approach see Madden (2001b).

in the social cost of tobacco consumption, in particular whether the costs of maternal smoking (in terms of the health costs of low-weight babies, sudden infant death syndrome etc) should be included and (b) assumptions regarding the time consistency of preferences. Gruber (2001), Gruber and Köszegi (2001) and Laux (2000) indicate that if preferences are *not* assumed to be time consistent then the internal cost of smoking should also be included in the social cost of smoking. This would imply huge tax increases over current levels. There is very little treatment of the optimal tobacco tax for Ireland but see Madden (1992) for an approach which attempts to infer the degree of consumption externality implicit in existing taxes.

The remainder of the paper is as follows: in section 2 we briefly discuss some of the existing literature and in section 3 we outline a simple model of starting and quitting smoking. In section 4 we discuss our data and describe and present results from our empirical model while section 5 provides concluding comments.

2. Review of Literature²

It was believed at one time that cigarette smoking and other addictive behaviour was not rational and so not suitable for conventional economic analysis (e.g. Schelling, 1984). There is now however a substantial body of literature to testify that the demand for cigarettes clearly responds to changes in prices and other factors. Early studies of cigarette demand employed aggregate time-series data and produced estimates of the price elasticity of demand in the region of -0.4 . One disadvantage of these studies was that they were unable to distinguish between the elasticity of cigarette demand conditional upon smoking and the elasticity of participation. Later studies used the type of individual level data employed in this study. These studies are able to consider separately the effect of price on the probability of smoking and on average consumption of smokers. Furthermore, studies on the probability of smoking can be divided into those which view starting and quitting as binary events within a discrete choice framework and those which use duration analysis. Madden (2001a) analysed the factors influencing female smoking and drinking patterns. However this paper only examined a single cross-section and so could not incorporate time series variation in price or tax data. The current paper remedies this by expanding the framework and extending the binary choice framework to include the effects of

² The first part of this section draws upon the excellent survey by Chaloupka and Warner (1999).

taxes/prices, while Madden (2001,b) analyses the same issues using a duration approach.

Studies which have examined smoking initiation in a discrete choice framework have typically estimated elasticities of participation with respect to tax in the region of -0.5 to -1.0 . While there is an extensive literature, the general consensus appears to be that there is an inverse relationship between age and smoking elasticity and that women are typically less responsive to price than men (for a summary see Chaloupka and Warner, 1999). As is outlined below the sample used here is a sample of younger women (all aged 48 or under) so there may be offsetting influences on estimated tax/price elasticities.

We complete this section by briefly reviewing the existing Irish studies on tobacco consumption. A variety of models of tobacco consumption have been estimated mostly using aggregate time-series data for Ireland dating from O’Riordan (1969) to Madden (1993).³ These studies have produced broadly comparable results with a median estimate for the price elasticity of tobacco in the region of -0.5 , which is in line with results from elsewhere in the world. The use of aggregate time-series data precludes distinguishing between the effect of price on the probability of smoking and on the demand for cigarettes conditional on smoking. Conniffe (1995) remedies this to some extent by combining analysis of aggregate time-series data with data on the proportion of the total population who are smokers. He found that the proportion of the population smoking is unaffected by price (or income) but exhibits a downward trend related to health concerns. Consumption by smokers does not exhibit such a downward trend but appears to have a significant price elasticity of around -0.3 .

We now turn to outline the simple model of starting and quitting smoking which underlies our analysis.

3. A Model of Starting and Quitting Smoking

In this section we outline a simple theoretical model which underlies our empirical approach. The model draws on the exposition of Douglas and Harihan (1994). Suppose each individual has a concave utility function at time t

$$U_t = U(C_t, Y_t, S_t, L_t)$$

³ The exception was O’Riordan (1969) who used data from the Tobacco Research Council.

where C_t is the level of consumption of the addictive good whose price is P_t , Y_t is consumption of a non-addictive numeraire good whose price is unity, S_t is the stock of accumulated addiction capital and L_t represents other demographic/life cycle variables which may affect utility.

The stock of addictive capital S_t depreciates at rate γ but it is replenished by current consumption of the addictive good C_t so that

$$S_{t+1} = (1 - \gamma)S_t + C_t.$$

Since the individual starts off with zero units of consumption $S_0 = 0$.

Assume that each individual is infinitely lived, then discounted remaining lifetime utility at time t , V_t is given by

$$V_t = \sum_{i=t}^{\infty} \frac{1}{(1 + \rho)^{i-t}} U_i$$

where ρ is the rate of time preference.

The lifetime budget constraint is determined by the present value of lifetime wealth A_t , the present value of lifetime expenditure on the numeraire good Y and the present value of lifetime expenditure on the addictive good C at prices P_t . We make the simplifying assumption that lifetime earnings are not affected by the stock of addiction.⁴ The budget constraint for the individual at time t is

$$\sum_{i=t}^{\infty} \frac{1}{(1 + r)^{i-t}} (Y_i + P_i C_i) = \sum_{i=t}^{\infty} \frac{I_i}{(1 + r)^{i-t}} \equiv A_t$$

where I_i is income at time i and r is the rate of interest. We can now look at the decisions to start and quit smoking. Dealing with starting first, a rational individual will begin smoking if the marginal benefit of the first cigarette exceeds its marginal cost i.e.

$$MB_C(C_t, Y_t, L_t | S_t = 0) > MC_C(C_t, Y_t, L_t | S_t = 0)$$

where MB_C is the marginal discounted remaining lifetime benefit of cigarette consumption while MC_C is the marginal discounted remaining lifetime cost. It seems likely that some of the variables affecting marginal cost and benefit will have a

⁴ There is some controversy as to the effect of the consumption of addictive goods on wages. Clearly ill-health (arising from smoking) could affect earnings via lost hours and there is also evidence that moderate alcohol consumption has a positive effect upon wages but that tobacco use reduces wages. See Auld (2000) for a recent discussion.

stochastic component. For example, they could both be affected by the occurrence of respiratory illnesses which would reduce the appeal of smoking or they could be influenced by the number of smokers in the potential smoker's peer group. So the above condition could be re-specified along the lines:

$$MB_t^* + \varepsilon_t > MC_t^* + \mu_t$$

where $MB_t^* \equiv E\{MB_C(C_t, Y_t, L_t | S_t = 0)\}$ and $MC_t^* = E\{MC_C(C_t, Y_t, L_t | S_t = 0)\}$.

Thus the probability of starting smoking at time t given that an individual has not started smoking in a previous period is

$$\begin{aligned} \Pr\{C_t > 0 | S_t = 0\} &= \Pr\{MB_C(C_t, Y_t, L_t | S_t = 0) > MC_C(C_t, Y_t, L_t | S_t = 0)\} \\ &= \Pr\{\varepsilon_t - \mu_t > MC_t^* - MB_t^*\}. \end{aligned}$$

Suppose we let $(MB_t^* + \varepsilon_t) - (MC_t^* + \mu_t) = Y_t^*$. Then we let $Y_t^* = Z_t' \gamma + u_t$ where Z_t' is a vector of variables determining smoking with γ the associated parameter vector and $u_t = \varepsilon_t - \mu_t$. Then the probability of starting to smoke is given by

$$\Pr(Y_t^* > 0) = \Pr(u_t > -Z_t' \gamma) = \Phi(Z_t' \gamma)$$

and we assume that u_t is an error term following a normal distribution $(0, \sigma_u)$, with $\Phi(\cdot)$ the standard normal C.D.F., with the variance of u_t normalised to one.

The analysis of quitting is very similar, except of course that marginal cost and benefit are now conditional upon a stock of accumulated addictive capital. A person will quit in period T if the following condition holds:

$$MC_C(C_t, Y_t, L_t | S_t > 0) > MB_C(C_t, Y_t, L_t | S_t > 0)$$

where $S_t > 0$ reflects the stock of addictive capital up to period T . Note that this assumes a single spell of smoking – we do not allow for multiple spells of smoking, not smoking, smoking again etc. Then, following the analysis above, the probability that someone will quit smoking in period T , given that they were smoking in period $T-1$ is

$$\Pr\{C_T = 0 | C_{T-1} > 0, S_t > 0\} = \Pr\{\varepsilon_T - \mu_T < MC_T^* - MB_T^*\}$$

Thus we have

$$\Pr(Y_t^* < 0) = \Pr(u_t < -Z_t' \theta) = 1 - \Phi(Z_t' \theta)$$

where note we have replaced the parameter vector γ with the vector θ since we do not wish to impose the condition that variables have a “symmetric” effect on starting and quitting.

4. Data and Empirical Model

In this section we discuss our data and the empirical model adopted. Our data comes from a survey known as the Saffron Survey which was carried out in 1998 by the Centre for Health Economics at University College Dublin.⁵ The Saffron Survey’s aim was to survey women’s knowledge, understanding and awareness of their lifetime health needs. Much of the focus of the survey was on the issue of hormone replacement therapy⁶ but other information regarding health, lifestyle choices and demographics was also collected. For our purposes in this paper the relevant questions regarding smoking were as follows: “Do you currently smoke?”. People who answered “yes” to this question were then asked “For approximately how many years have you smoked?”. People who replied that they did not currently smoked were asked had they ever smoked and if they answered yes to this question they too were asked for approximately how many years they had smoked, and in what year they had stopped smoking. From the answers to these questions it is possible to calculate the year people started (and stopped if applicable) smoking. The great advantage of this type of information is that it is possible to examine the effect of the tax rate in each given year on the probability of starting/quitting smoking.

One problem which potentially arises in this analysis is the use of the word “approximately” in the question regarding the duration of smoking. There is a danger here of “heaping” in the sense that people will round off their answer to this question to the nearest 5/10 years. There are a variety of techniques of addressing this issue (see Torelli and Trivellato, 1993, for a comprehensive discussion) but here we adopt the ad hoc approach of simply including dummy variables for the years where heaping is likely (viz. five, ten, fifteen and twenty years before the date of the survey).

Before the formal analysis it is useful to look at some summary information on our sample. The original sample size for the Saffron survey was 1260. However, since we only have tax and price data going back as far as 1960, we have dropped all women who were aged 10 or more in 1960. We are effectively assuming that subjects

⁵ I am grateful to Joe Durkan and the Centre for Health Economics for supplying this data.

⁶ See Thompson, 2000.

were at risk of starting smoking from the age of ten. Our data suggests that this is a reasonable assumption since the number of subjects who reported starting smoking before ten was miniscule. Thus we only have women who were born after 1950, leaving us with a total sample of just over 700. Of these, about half have smoked at some stage of their lives and about 35 per cent were smoking at time of interview. In table 1 we give summary statistics (with standard errors in brackets) for a number of key variables for the various subgroups in our sample.

There is relatively little difference across the groups by age except for ex-smokers who tend to be older. As might be expected this group also tends to have worse health (which perhaps prompted them to quit smoking). They also show a higher proportion of married, which may reflect people giving up smoking on getting married. Probably the biggest difference across the columns is to be observed in educational attainment. Of the total population (including smokers) over 60 per cent have obtained Leaving Cert or higher, but of those who have ever smoked only about 47 per cent have. This drops to about 44 per cent when we examine those people still smoking in 1998. Thus getting beyond Junior Cert appears to not only lower the chances of starting smoking, but also increases the chances of quitting if you do start to smoke.

As explained above, the Saffron survey was a cross-section survey carried out in 1998. However, we are exploiting the retrospective information which enables us to examine the impact of a time-varying covariate such as tax or price on the decision to start/quit smoking. One issue which must first be discussed is the choice of tax/price. The choice of such a variable is motivated by the theory of consumer demand which suggests that the quantity consumed (or in this case the decision to consume) will be influenced by a number of factors, including the consumer price (which in turn is influenced by the tax on tobacco).

The tax element in the retail price of a packet of cigarettes has two components, a specific excise duty and value-added tax (VAT). Thus excise duty is added to the producer price and VAT is then applied at the appropriate rate to obtain the retail price. While the retail price is thus influenced by two tax instruments (the rate of excise duty and VAT) it is arguable that only excise duty can be regarded as a specific tax instrument to address smoking, since any increase in the rate of VAT will also cause the prices of many other goods to rise. To engineer a rise in the relative price of tobacco, a rise in excise duty in excess of the rise in the general price level is

appropriate. Unfortunately the data supplied to us by the Revenue Commissioners does not break down the tax component into excise and VAT for the period up to 1973. Thus we have taken the total tax component of the retail price and deflated it by the personal consumption deflator to arrive at a real tax on tobacco. This sidesteps the need for such a breakdown since any excise tax increase in excess of overall inflation will appear as an increase in the real tax whereas increases in VAT will also be reflected in increases in the overall price level and thus contribute less to any increase in the real tax.⁷

We thus have a choice between using the real tax content or the consumer price as the relevant time-varying covariate. It can be argued that from the point of view of the decision which the consumer makes re starting or quitting it is the consumer price which is relevant. On the other hand, from the point of view of government it is the tax content which is the policy variable. However, from a practical point of view, the choice between them is largely irrelevant. As figure 1 below shows, the two series move pretty much in tandem and the correlation coefficient between them is 0.97.

We now turn to discuss the more formal analysis of starting and quitting, dealing with starting first.

4.1 Starting Smoking

To analyse the decisions to start smoking, we employ standard binary choice analysis. When modelling the decision to smoke, we include as one of our covariates the tax rate for the year in question. Thus say we observe woman A, aged 40 in 1998 (the year of the survey) who commenced smoking aged 20 (i.e. in 1978). We assume people are at risk of starting smoking from the age of ten (1968 in the case of woman A). Thus we will have ten observations on woman A where she does not smoke (i.e. in the (0,1) framework she chooses zero) followed by year (observation) 11 where she does smoke (i.e. chooses one). Each observation for each year for this woman (up to when she starts smoking) is regarded as a separate observation. Consider now the case of woman B with the same age as woman A but who has not started smoking by 1998. In this case there are thirty observations for woman B, and in each case the choice is zero. Thus the original data set of just over 700 is “expanded” to take

⁷ Delipalla and O’Donnell present evidence that changes in specific taxes have a greater impact upon price than changes in ad valorem taxes in the European cigarette industry (Delipalla and O’Donnell, 2001).

account of the time-varying covariate (tax) using the retrospective information provided. Along with tax we employ two other time-varying covariates. To try and capture the influence of government campaigns to deter smoking we include dummy variables for both the TV and radio bans on tobacco advertising.

We also include non time-varying covariates. Education is typically found to be a very important explanatory variable for smoking. The mechanism whereby education affects smoking behaviour is unclear. It may indicate that more educated people simply have more information regarding the effects of smoking upon health. It may also indicate that more educated people are better able to process or act upon information on regarding the health effects of smoking. Finally it may reflect the presence of a “third” variable which simultaneously influences attitudes towards both education and smoking/health. Thus individuals with a low discount rate (i.e. they are more “future-oriented”) will invest in both their health capital (by refraining from activities such as smoking) and their human capital. While we do include a measure of health knowledge (see below) in the absence of reliable measures of such discount rates it is difficult to distinguish between these different mechanisms but it is likely that all three (and perhaps others) are at work.⁸

Note that the education variable here refers to the highest level achieved, a level which will not have been achieved by the subject for a number of the years at which she was at risk of starting smoking e.g. from age ten to twenty it is very unlikely that any person would have a third level degree. However, if the highest level of education achieved acts as a proxy for a variable such as a person’s discount rate (see the argument above) then its inclusion for all years at which the subject was at risk is valid.

We also include a variable for marital status. Once again, for part of the period under review a number of the subjects will not be married (even though the data here will categorise them as such). Once again however, it seems reasonable that marriage may be correlated with unobserved preferences and so its inclusion at all years at which the subject was at risk is valid.. This argument could be summed up along the lines that “the sort of people who tend to marry are different from the sort that tend not to marry”.

⁸ For a discussion on the relative importance of these mechanisms for the link between smoking, health and socio-economic status, see Meara (2001).

We also include a variable which we label health knowledge. As mentioned above, the Saffron survey collected a variety of information regarding the health habits and needs of women. Owing to its concentration on hormone replacement therapy, a number of questions were asked regarding health knowledge in this area. As our measure of health knowledge we include a dummy variable which measures the response to the question “Have you ever heard of osteoporosis?”. Clearly this question refers to a dimension of health which differs from smoking, but we do not believe it is unreasonable to expect that knowledge regarding osteoporosis may be correlated with other aspects of health knowledge, including the health effects of smoking. The inclusion of this variable may also help to disentangle, to some extent at least, the mechanism whereby education affects smoking (see discussion above).⁹

To allow for the possibility of a secular drift in smoking habits over time, perhaps related to increased health awareness or general public intolerance towards smoking we also include a time trend. However, given that all the variation in tax rates is attributable to variation across calendar years there may be an identification problem in separating the time trend and tax effects. Following Foster and Jones (2000) we thus include a fourth-order polynomial in time, which allows for a smooth but flexible time trend. We also try a linear spline in time with three “knots”. Finally, we also include a cohort dummy, which takes on a value of one if the individual is aged 33 or less.

The results of a probit on starting are given in table 2 (results are presented in the form of marginal effects). Three specifications are presented, one with a fourth order polynomial in time, one with a linear spline and one where no account is taken of time. The coefficients for the education variables, marital status, health knowledge, and the year dummies are all fairly robust to the different specifications. In all cases the coefficients are of the expected sign and for the most part are statistically significant. One interesting feature of the education variables is the presence of an inverse U shaped response of the probability of smoking to educational achievement. Compared to the default of leaving school following primary education (or earlier), if completion of the Junior Cert is the highest educational level achieved

⁹ In future research we hope to include other measures of health knowledge apart from osteoporosis. Nevertheless, osteoporosis may be a suitable measure of health knowledge for our sample since typically it is more common amongst older women thus reducing the chances that knowledge regarding it comes from direct experience but rather instead from being generally well-informed on health issues. Also since smoking increases the risk factor for osteoporosis it may be a good proxy for health knowledge specifically related to smoking.

then the probability of smoking is increased. If the highest education level achieved is the Leaving Cert or higher then the probability of starting to smoke decreases.

The inclusion of health knowledge leads to a slight fall in the size of the education coefficients but they are still significant. The fact that education retains its significance despite the inclusion of a variable which takes account of health knowledge, (albeit in an imperfect way), is of interest. This indicates that higher education reduces the probability of starting to smoke in ways apart from increased health knowledge.

The coefficients on the TV and radio bans show some sensitivity to the time specification. Where the fourth order polynomial is used the coefficients are significant but in the opposite direction from what would be expected. The positive coefficients suggest that such bans are associated with an *increased* probability of starting smoking. The coefficients on these variables are insignificant for the other specifications. As outlined in Chaloupka and Warner (1999) there can be considerable difficulties in finding an effect of advertising bans on smoking behaviour, not least because tobacco companies have been quite ingenious in devising ways of promoting smoking apart from direct advertising e.g. sponsorship of sporting events etc.

The coefficient on the cohort effect is positive indicating that women born after 1965 appear to have a higher propensity to start smoking.

Finally, the coefficient on tax is in the expected direction for all specifications and is significant for the fourth order polynomial in time and when no account is taken of time. The size of the coefficient also is sensitive to the specification adopted for time. When the fourth order polynomial is used the coefficient is at its largest. The size of the coefficient drops by about a third when the linear spline is used and by a further third when no account is taken of time. The statistical significance drops quite sharply when the linear spline is used but picks up again when no time trend is included. Thus overall, there is some evidence of a significant effect of taxation on the probability of starting smoking. A coefficient on the log of tax of -0.032 implies an elasticity of about -1 , which is quite high by international standards.¹⁰

¹⁰ Finally, as an alternative method of accounting for secular trends in smoking we also included the smoking rate for women in the UK. This is clearly exogenous and it is arguable that it captures general trends re smoking in Western Europe. We do not present the results here (they are available on request) but the inclusion of this variable has very little qualitative effect on the results for the starting models.

4.2 Quitting Smoking

For the case of quitting smoking the analysis is in many ways the mirror image of the analysis reported above. One important difference is that the sample is necessarily smaller, since it can only include those people who are (or were) smokers. Aside from that the analysis is similar to the case of starting. Thus a person who has smoked for say 10 years and then quits in the eleventh year represents eleven observations, ten with “quit” taking on a zero value and one with “quit” taking on a value of unity. A person who say starts smoking in 1988 and has not quit by 1998 (the year of the survey) is simply treated as having ten observations with “quit” equal to zero.

Table 3 presents results for the probit for quitting (once again results are presented in the form of marginal effects). Again, three specifications are presented, one with a fourth order polynomial in time, one with a linear spline and one where no account is taken of time.¹¹ Here we see that the coefficients on education, the advertising bans, marital status, health knowledge and the yearly dummies are all fairly insensitive to the time specification. The education coefficients and that on health knowledge are of the expected sign although it is noticeable that having the Junior Cert as the highest education level achieved exercises no effect upon quitting, whereas it increased the probability of starting. This is noteworthy because it is worth remembering that the sample for starting smoking and that for quitting smoking are not identical. Thus, for the sample of smokers, the impact of the Leaving Cert and third level education is negative with regard to smoking (as in the case of starting), but there is no effect from the Junior Cert (unlike the case of starting).

The coefficient for the cohort effect suggests that those born after 1965 have less of a tendency to quit. This may reflect the fact that many people do not choose to quit until their late thirties or forties, so this group had simply not reached that age at the time the sample was taken.

The sign of the coefficients on the year dummies is surprising. If there is “heaping” in the sense that when asked a retrospective question people will tend to round off to five or ten-yearly intervals then we would expect positive coefficients.

¹¹ As with starting we also included the smoking rate for UK women, but once again the qualitative results were very similar.

Instead we have negative coefficients which in the case of ten and twenty years are significant.

The coefficient on tax is insignificant for the specifications with a polynomial in time and with a linear spline. Only where no account is taken of time do we observe a significant effect of tax, and it is in the expected direction. Higher tax increases the probability of quitting. The implied tax elasticity of quitting is about 0.8, slightly smaller (in absolute terms) than that for starting but still of the same order of magnitude.

Overall, it seems fair to suggest that the evidence for an effect of taxation on quitting smoking is less clearcut than in the case of starting. The sensitivity of the estimated coefficients to the inclusion of a time trend indicates some identification problems.

5. Discussion and Conclusion

This paper has examined the factors influencing starting and quitting smoking for a sample of Irish women using discrete choice analysis. It complements other work carried out on the same data set using duration analysis (see Madden, 2001b). The innovation in the paper is that retrospective data in the sample allows for the inclusion of the real tax on tobacco as a time-varying covariate, thus permitting analysis of the effectiveness of a major policy variable in terms of combating smoking. The evidence presented here does indicate a role for taxation in affecting the decision to start smoking, but its role in the decision to quit smoking is not so clearcut. In particular, the effect of taxation in the quitting model was quite sensitive to the inclusion of a time trend, indicating some identification problems.

Results for other variables were also of interest. Predictably education played an important role, with higher lifetime educational achievement having an inverse U shaped effect on starting smoking and a positive effect on the probability of quitting smoking. The inclusion of a proxy for health knowledge tended to lower the coefficient on education indicating that part of the traditional role assigned to education reflects greater health knowledge among higher educated people. The precise mechanism whereby education affects health behaviour and smoking in particular is something we hope to return to in future research. Finally, the inclusion of variables reflecting advertising bans on tobacco produced results contrary to

intuition with these variables either having no effect or else *increasing* the probability of starting smoking.

Overall, the results in this paper are probably more suggestive than definitive in terms of the role of tobacco taxes in influencing starting and quitting. It should also be borne in mind that the results here apply only to a sample of women aged 48 or under. However, given the wealth of results from other countries and time periods regarding the effect of taxes and prices on tobacco consumption, it is clear that tobacco taxation is likely to remain a major instrument in public policy to discourage smoking.

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Table 1: Summary Statistics for Sample

Variable	Total (N=703)	Ever Smoked (N=348)	Smokers (N=246)	Ex-Smokers (N=102)
Age	34.38265 (8.697518)	34.70977 (8.701864)	33.02846 (8.511409)	38.76471 (7.806035)
Age Started Smoking		19.35777 (5.294379)	19.37295 (5.169976)	19.31959 (5.622771)
Health Problem	.1038407 (.305271)	.1264368 (.3328195)	.1178862 (.3231307)	.1470588 (.3559135)
Single	.3499289 (.4772868)	.3390805 (.4740788)	.4065041 (.4921821)	.1764706 (.3831026)
Married	.5860597 (.4928887)	.591954 (.4921794)	.5284553 (.5002074)	.745098 (.4379582)
Widowed	.0085349 (.0920547)	.0057471 (.0757005)		.0196078 (.1393331)
Separated	.0554765 (.229071)	.0632184 (.2437058)	.0650407 (.2471003)	.0588235 (.2364561)
Primary Education	.1052632 (.3071107)	.1293103 (.3360263)	.1463415 (.3541688)	.0882353 (.2850375)
Junior Cert	.2745377 (.4465988)	.3821839 (.4866208)	.4146341 (.4936632)	.3039216 (.4622205)
Leaving Cert	.4054054 (.4913199)	.3189655 (.4667468)	.2723577 (.4460806)	.4313725 (.4977137)
Third Level	.2147937 (.4109716)	.1695402 (.3757687)	.1666667 (.3734378)	.1764706 (.3831026)
Working	.5504979 (.4977976)	.4971264 (.5007117)	.4756098 (.5004229)	.5490196 (.5000485)
Cigarettes per Day		15.47977 (8.827224)	15.0449 (8.063403)	16.53465 (10.42071)

Table 2: Starting Smoking (N=11733)

Junior Cert	0.008 (0.005)	0.009 (0.005)	0.009 (0.005)*
Leaving Cert	-0.011 (0.004)**	-0.011 (0.004)**	-0.011 (0.004)**
Third Level	-0.010 (0.004)**	-0.010 (0.004)**	-0.010 (0.004)**
Ln (Tax)	-0.034 (0.017)**	-0.022 (0.033)	-0.016 (0.008)**
TV Ban	0.015 (0.006)**	0.012 (0.007)*	0.001 (0.006)
Radio Ban	0.015 (0.008)*	0.009 (0.009)	-0.007 (0.005)
Married	-0.007 (0.003)*	-0.007 (0.004)**	-0.007 (0.004)**
Health Knowledge	-0.005 (0.004)	-0.005 (0.005)	-0.006 (0.005)
Young Cohort	0.013 (0.004)**	0.013 (0.004)**	0.012 (0.004)**
Time	0.022 (0.006)**		
Time ² /100	-0.260 (0.058)**		
Time ³ /1000	0.099 (0.021)**		
Time ⁴ /10000	-0.012 (0.003)**		
Time 1		0.002 (0.002)	
Time 2		-0.006 (0.003)**	
Time 3		0.004 (0.004)	
Time 4		0.000 (0.002)	
5 Years	0.021 (0.011)*	0.036 (0.014)**	0.035 (0.013)**
10 Years	0.055 (0.015)**	0.060 (0.016)**	0.060 (0.014)**
15 Years	0.041 (0.016)**	0.028 (0.015)*	0.028 (0.012)**
20 Years	0.122 (0.033)**	0.124 (0.035)**	0.072 (0.018)**

* significant at 10%;
 ** significant at 5%;
 *** significant at 1%

Table 3: Quitting Smoking (N=8625)

Junior Cert	0.003 (0.004)	0.003 (0.004)	0.003 (0.004)
Leaving Cert	0.013 (0.005)**	0.013 (0.005)**	0.013 (0.005)**
Third Level	0.023 (0.009)**	0.023 (0.009)**	0.023 (0.009)**
Ln (Tax)	0.007 (0.018)	-0.024 (0.030)	0.022 (0.008)**
TV Ban	-0.004 (0.015)	-0.006 (0.013)	0.004 (0.005)
Radio Ban	-0.012 (0.013)	-0.016 (0.013)	-0.002 (0.005)
Married	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)
Health Knowledge	0.012 (0.003)**	0.012 (0.003)**	0.012 (0.003)**
Young Cohort	-0.010 (0.004)**	-0.010 (0.004)**	-0.010 (0.004)**
Time	-0.003 (0.004)		
Time ² /100	0.026 (0.050)		
Time ³ /1000	-0.007 (0.020)		
Time ⁴ /10000	0.001 (0.002)		
Time 1		-0.001 (0.001)	
Time 2		0.000 (0.003)	
Time 3		0.004 (0.004)	
Time 4		-0.003 (0.002)	
5 Years	-0.008 (0.006)	-0.008 (0.006)	-0.008 (0.006)
10 Years	-0.011 (0.005)*	-0.012 (0.005)**	-0.011 (0.005)**
15 Years	0.010 (0.011)	0.016 (0.013)	0.007 (0.009)
20 Years	-0.014 (0.006)**	-0.013 (0.006)**	-0.011 (0.007)

* significant at 10%;

** significant at 5%;

*** significant at 1%

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